What is claimed is:

1. A method of transmitting and receiving a signal through a channel with time-reversed impulse response, comprising the steps of:

time-reversing the original signal;

transmitting the time-reversed signal over the channel;

storing and time-reversing the received signal.

2. A method of transmitting a signal of the type comprising a sequence of symbols over spaced antennas, or antennas of different polarization, to reduce fading and intersymbol interference, comprising the steps of:

dividing the sequence of symbols into two sequences;

dividing the transmission frame into two blocks;

processing the symbols in said two sequences so that some of the symbols in at least one of the sequences are time-reversed, some of the symbols in at least one of the sequences are complex conjugated, some of the symbols in at least one of the sequences are negated, and;

during one of the blocks of the transmission frame, applying one processed symbol sequence to a first antenna and the other processed signal sequence to a second antenna and during the other block of the transmission frame applying the other processed symbol sequence to the first antenna and the one processed symbol sequence to the second antenna.

3. The method of claim 2 in which all of the symbols in the symbol sequence of the one and the other symbol sequence are processed during said one block of the transmission frame applying the one unprocessed signal sequence to the first antenna and the other to the second antenna, and during the block of the transmission applying the processed other symbol sequence to the first antenna and the one processed signal sequence to the other antenna.

4. A transmitter for transmitting signals of the type comprising a sequence of symbols over spaced antennas, or antennas of different polarization, to reduce fading while handling intersymbol interference efficiently, comprising:

a divider for dividing the sequence of symbols into two sequences;

a divider for dividing the transmission frame into two blocks;

a processor for processing the symbols in said two sequences so that some of the symbols in at least one of the sequences are time-reversed, some of the symbols in at least one of the sequences are complex conjugated, some of the symbols in at least one of the sequences are time reversed, and;

means for applying during one block of a transmission frame one processed symbol sequence to a first antenna and the other processed signal sequence to a second antenna and during the other block in the transmission frame applying an other processed symbol sequence to the first antenna and applying an yet an other processed symbol sequence to the first antenna.

5. A method for processing and transmitting a signal comprising a plurality of symbols, the system comprising a first and a second spaced antennas coupled to a transmitter, said method reducing the effect of fading while handling intersymbol interference efficiently, comprising the steps of:

dividing symbols of the signal into a first and a second symbol stream wherein the first and second symbol streams each have at least two symbols;

dividing a transmission frame into a first and a second transmission block;

transmitting the first symbol stream from the first antenna during the first transmission block and transmitting the second symbol stream from the second antenna during the second transmission block;

time reversing, taking the complex conjugate form of and negating the second symbol stream;

time reversing and taking the complex conjugate form of the first symbol stream; and

transmitting from the first antenna during the second transmission block the second symbol stream in the time reversed, complex conjugate and negated form, and

transmitting from the second antenna the first symbol stream in the time reversed and complex conjugate form.

6. The method of claim 5 wherein the method for processing and transmitting a signal further comprises each symbol having a symbol value, wherein the step of dividing symbols further comprises the step of assigning symbols to the first symbol stream and the second symbol stream in a random fashion with respect to each symbol value.

7. The method of claim 6 wherein the step of dividing symbols further comprises the step of assigning at least one training symbol, which is a non-data part of the signal, to each of the first and the second symbol streams.

8. The method of claim 7 wherein the step of assigning at least one training symbol to each of the first and the second symbol streams further comprises the step of assigning a number of training symbols equal to the anticipated delay spread to each of the beginning and the to end of the first and the second symbol streams.

9. The method of claim 5 wherein the method for processing and transmitting a signal further comprises a first and a second group of spaced antennas, each group comprising a plurality of antennas, wherein the step of transmitting the first symbol stream from the first antenna during the first transmission block and transmitting the second symbol stream from the second antenna during the first transmission block is replaced by the step of transmitting the first symbol stream from the first group of antennas during the first transmission block using a delay diversity technique and transmitting the second symbol stream from the second group of antennas during the first transmission block using a delay diversity technique; and

wherein the step of transmitting from the first antenna during the second transmission block the second symbol stream in the time reversed, complex conjugate and negated form, and transmitting from the second antenna the first symbol stream in the time reversed and complex conjugate form is replaced by the step of transmitting

from the first group of antennas using a delay diversity technique during the second transmission block the second symbol stream in the time reversed, complex conjugate and negated form, and transmitting from the second group of antennas using a delay diversity technique the first symbol stream in the time reversed and complex conjugate form.

10. The method of claim 9 wherein the system for processing and transmitting a signal further comprises the first and the second groups of antennas having different polarizations.

11. In a method for receiving and processing a signal transmitted as in claim 2 comprising the steps of:

receiving the symbol streams in the first block;

receiving the symbol streams in the second block;

time reversing and taking the complex conjugate form of the symbol streams in the second block; and

filtering the symbol streams in the first block and the time reversed, complex conjugate form of the symbol streams in the second block to form decoupled outputs.

12. The method of claim 11 wherein the step of filtering further comprises a matched filter according to

$$\begin{bmatrix} z_1(t) \\ z_2(t) \end{bmatrix} = \begin{bmatrix} h_1^*(q) & h_2(q^{-1}) \\ h_2^*(q) & -h_1(q^{-1}) \end{bmatrix} \begin{bmatrix} r_1(t) \\ r_2(t) \end{bmatrix}$$

where $h_1(q^{-1})$ is a time-discrete linear finite impulse response filter described as a polynomial in the unit delay operator $q^{-1}$, describing the channel associated with the signals transmitted over antenna 1 and $h_2(q^{-1})$ is the corresponding description of the channel associated with signals transmitted from antenna 2. The polynomials $h_1^*(q)$ and $h_2^*(q)$ in the unit advance operator $q$ represent the effective channel experienced by signals that are time reversed, transmitted from antenna 1 and antenna 2 respectively, and whose received sequence of samples are time reversed. The signals $r_1(t)$ and $r_2(t)$ are the received and processed signals of claim 7. The signal $r_1(t)$ is

the signal received during the first block of the frame and the signal $r_2(t)$ is the signal received during the second block of the frame, time reversed and complex conjugated. The signals $z_1(t)$ and $z_2(t)$ are the output after the matched filtering. The signals $z_1(t)$ and $z_2(t)$ are decoupled in the sense that $z_1(t)$ only depends on $d_1(t)$ and $z_2(t)$ only depends on $d_2(t)$.

13. The method of claim 11 further comprising the step of:

after the step of filtering, estimating the signal in symbol stream $d_1(t)$ from signal $z_1(t)$ and symbol stream $d_2(t)$ from signal $z_2(t)$.

14. The method of claim 11 where the signal is received by multiple antennas and is combined in order to increase the signal quality and reduced the interference and otherwise is processed as in claim 7.

15. A method for transmitting data while reducing the effects of fading and handling intersymbol interference efficiently comprising:

a transmitting station including:

(a) a first antenna and a second antenna; and

(b) an encoder coupled to the first and second antennas and adapted to divide a signal into a first and a second symbol stream, each symbol stream having a plurality of symbols, the encoder adapted to transmit the first symbol stream through the first antenna during a first block of a transmission frame, to transmit the second symbol stream through the second antenna during a first block of a transmission frame, to transmit through the second antenna a time reversed and complex conjugate form of the first symbol stream during a second block of a transmission frame, and to transmit through the first antenna a time reversed complex conjugate and negated form of the second symbol stream during a second block of a transmission frame.

16. The system of claim 15 wherein each symbol has a symbol value and the encoder is further adapted to assign the symbols to each of the first symbol stream and the second symbol stream in a random fashion with respect to each symbol value.

17. The system of claim 15 wherein the encoder is further adapted to assign at least one training symbol, which is a non-data part of the signal, to each of the first and second symbol streams.

18. The system of claim 17 wherein the encoder is further adapted to assign a number of training symbols, which is a non-data part of the signal, equal to the delay spread to each of the beginning and to the end of each of the first and the second symbol streams.

19. A system for transmitting data while reducing the effects of fading and handling intersymbol interference effectively comprising:

a transmitting station including:

(a) a first antenna group and a second antenna group, each group comprising a plurality of antennas; and

(b) an encoder coupled to the first and second antenna groups and adapted to divide a signal into a first and a second symbol stream, each symbol stream having a plurality of symbols, the encoder adapted to transmit the first symbol stream through the first antenna group using a delay diversity technique during a first block of a frame, to transmit the second symbol stream through the second antenna group using a delay diversity technique during a first block of a frame, to transmit through the second antenna group a time reversed and complex conjugate form of the first symbol stream during a second block of a frame, and to transmit through the first antenna group a time reversed complex conjugate and negated form of the second symbol stream during a second block of a frame.

20. The system in claim 19 wherein the antennas within each group are spaced apart from one another.

21. The system in claim 20 wherein the antennas within each group have polarizations different from one another.

22. The system in claim 20 further comprises:

a first and a second antenna within the first antenna group; and

the encoder is further adapted to use a delay diversity technique wherein the encoder begins transmitting the first symbol stream from the first antenna and after a delay period the encoder begins transmitting the first symbol stream from the second antenna.

23. The system of claim 22 wherein each symbol has a symbol value and the encoder is further adapted to assign the symbols to each of the first symbol stream and the second symbol stream in a random fashion with respect to each symbol value.

24. The system of claim 23 wherein the encoder is further adapted to assign at least one training symbol, which is a non-data part of the signal, to each of the first and second symbol streams.

25. The system of claim 24 wherein the encoder is further adapted to assign a number of training symbols, which is a non-data part of the signal, equal to the anticipated delay spread to each of the beginning and to the end of each of the first and the second symbol streams.

26. The system in claim 19 wherein the antennas within each group are spaced apart from one another.

27. The system in claim 19 wherein the antennas within each group have polarizations different from one another.

28. A system for receiving and processing data transmitted pursuant to claim 15 or 19 while reducing the effects of fading and handling intersymbol interference efficiently comprising:

a receiving station including:

(a) an antenna adapted to receive symbols from a transmission, the transmission divided into a first block and a second block, each block comprising a first symbol stream and a second symbol stream, each symbol stream comprising a plurality of symbols;

(b) a combining filter coupled to the antenna and adapted to receive symbols through the antenna from the first block and the second block wherein the combining filter generates a time reversed and complex conjugate form of the second block; and

(c) a matched filter coupled to the combining filter and adapted to receive the first block of the transmission and the time reversed, complex conjugate form of the second block and form a decoupled first and second output.

29. The system of claim 28 further comprising an equalizer adapted to resolve intersymbol interference in the first and second blocks.

30. The method of claim 28 wherein the step of filtering further comprises a matched filter according to

$$\begin{bmatrix} z_1(t) \\ z_2(t) \end{bmatrix} = \begin{bmatrix} h_1^*(q) & h_2(q^{-1}) \\ h_2^*(q) & -h_1(q^{-1}) \end{bmatrix} \begin{bmatrix} r_1(t) \\ r_2(t) \end{bmatrix}$$

where $h_1(q^{-1})$ is a time-discrete linear finite impulse response filter described as a polynomial in the unit delay operator $q^{-1}$, describing the channel associated with the signals transmitted over antenna 1 and $h_2(q^{-1})$ is the corresponding description of the channel associated with signals transmitted from antenna 2. The polynomials $h_1^*(q)$ and $h_2^*(q)$ in the unit advance operator $q$ represent the effective channel experienced by signals that are time reversed, transmitted from antenna 1 and antenna 2 respectively, and whose received sequence of samples are time reversed. The signals $r_1(t)$ and $r_2(t)$ are the received and processed signals of claim 7. The signal $r_1(t)$ is the signal received during the first block of the frame and the signal $r_2(t)$ is the signal received during the second block of the frame, time reversed and complex conjugated. The signals $z_1(t)$ and $z_2(t)$ are the output after the matched filtering. The signals $z_1(t)$ and $z_2(t)$ are decoupled in the sense that $z_1(t)$ only depends on $d_1(t)$ and $z_2(t)$ only depends on $d_2(t)$.

31. The system of claim 30 further comprising:

an estimator adapted to estimating the signal from the decoupled outputs $z_1(t)$ and $z_2(t)$.

32. The method of claim 11 where the signal is received by multiple antennas and is combined in order to increase the signal quality and reduced the interference and otherwise is processed as in claim 7.

33. The system of claim 11 or 12 further comprising an equalizer adapted to resolve intersymbol interference in the first and second blocks.

34. A method for receiving and processing symbol sequences transmitted in accordance with claims 2, 3 or 5 comprising processing the received symbol sequences so that the detection of the symbol streams $d_1(t)$ and $d_2(t)$ effectively decouple into detection of two separate symbol streams rather than joint detection of two symbol streams, thereby considerably simplifying the detection.